Improving the performance of the railways

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Abstract

All stakeholders in railways in Europe agree that the volume of rail transport has to grow in the coming decennia. The spectacular growth that is needed requires a further integration of the railway processes and sharing of information among railway players. A method has been developed to assess the performance of the railways, and to study the influence of changes in lower level performance indicators to the overall transport volume. This paper describes the method and the software that is used to support a performance assessment exercise.

The method is developed in the framework of the European research project InteGRail. The main results of the InteGRail project will be an information sharing platform that allows stakeholders to share information on the performance of their process. This way all stakeholders can optimise their contribution to the overall railway performance goals, rather than optimising their own performance, which could lead to sub-optimisation.

In the InteGRail project, the KPI Assessment tool is used to evaluate the effect of information sharing examples, which are implemented and demonstrated in 2008, the last year of the 4-year project.

Introduction: Growing rail transport volume as a goal for Europe

Europe is growing, and with the growing level of economy, the transport volume is growing even harder. All main players involved in railway strategy in Europe, the European Commission, Member States, individual Railway Undertakings and Infrastructure Managers and their European representative bodies, have agreed to make an effort to grow the transport volume of railways, both for passenger and freight operations. In order to double the market share of rail in the European transport context of fast growing transport volumes, rail transport volumes have to be doubled or sometimes even tripled in 20 years [1]. This growth is needed to prevent further growth of traffic congestion, air pollution, global warming and traffic accidents.

While integrated thinking was probably more common in state owned railway companies with all responsibilities under one general director, in the present situation in most European countries, railway processes become more and more separated. As a default, state controlled infrastructure management is often separated from railway operations following a European directive, and often also maintenance activities are left to subcontractors in the market, both for rolling stock and infrastructure. And while separation of company responsibilities has helped creating an open market, separation of processes has the risk of reducing awareness of the overall performance, and thus the risk of impeding rail transport growth.

Integration is needed, not in the sense of merging companies, but in the way that in terms of process optimisation all processes are seen as a part of one big railway system. Apart from competition between individual railway operators operating a similar service on the same network, most railway activities can be seen as a coherent set of actions, aiming at transporting a maximum volume of passengers or freight. It is needless to say that this has to happen at a price that is acceptable for the public and for society.

Defining one overall process performance in terms of transport volume will help to identify where cooperation, integration and information sharing are needed most.

The KPI Assessment Tool that is developed in the European project InteGRail will serve the purpose of optimising this overall performance, in a way that is agreed between all players in the railways.
InteGRail: Growing volume and increasing performance by sharing information

Many initiatives exist to help the growth of rail transport as the most sustainable transport mode. These initiatives can be found on all levels, from local to international, and with varying scopes, from information technology research to international logistics and transportation studies. One initiative is the European project InteGRail (Intelligent Integration of Railway Systems), where an IT platform is defined and developed that allows the main actors in railways (operators, traffic managers, infrastructure managers and rolling stock managers) to share information on their processes, allowing an improvement of their performance.

InteGRail is a 4-year project that started in 2005, the consortium doing the work consists of 40 companies, institutes and universities representing the major European railway companies, railway industry, universities and research and consultancy companies.

It is well understood and commonly agreed that many players could benefit from information that is only available from another player’s process. Some examples for illustration: (i) understanding of the impact of a failure on board of a train in service on its performance made available to the traffic managers, or (ii) present and future availability of the infrastructure for the timetable planners and the operators.

Today’s information technology solutions allow for advanced optimisation of decision making in railways. InteGRail aims at enabling information exchange, allowing better decisions to be taken, based on more accurate, more focused information. The InteGRail Information System, IGRIS, will allow the combination of any railway information source to provide exactly the information a decision maker in one of the stakeholders’ organisations needs to optimise the performance of his process.

The platform that is being defined in the project will be universal, which means that in principle any railway information system could be connected to any other information system or user application. To demonstrate that the platform actually allows such examples of data and information sharing, a limited number of examples of information management functionalities is implemented. These examples are chosen from a list that was derived from an international survey carried out in the project. In this survey railway companies were asked for their main performance goals, and were asked to indicate which information from elsewhere in the railway process would help them optimise their own performance. A tree (or decomposition) of railway performance indicators was used to help companies define what their specific role in the whole of railway processes is. Decomposing the Key Performance Indicators used in the countries in the project lead to a generic railway KPI Tree.

From a long list of information needs, a number of functions was chosen to be developed in the project. A description of the railway process in terms of business scenarios was used to create a demonstrator setting, where each of the developed functions could be proven to work.

Three demonstration scenarios resulted:

In the first demonstration scenario it will be proven how the setting up and the running of a new international freight train service could be improved if more information would be easily available. One of the examples here is the easily accessible information on railway networks with all their properties, so operators can verify if certain international destinations are reachable with their locomotives.

Another demonstration scenario deals with the optimisation of rolling stock and infrastructure maintenance, in a situation where all players have access to one another’s monitoring information. The assumption is that reliability and availability of both trains and track can be improved once condition information for these assets is openly available, both across company borders and country borders.

The third demonstrator aims at determining type and impact of an (incipient) failure on a passenger train that occurs while the train is in service and informing all stakeholders adequately about this failure. Failure prevention and failure management can probably be optimised once information sharing is dedicated and quick.

In each of these demonstration scenarios, which are planned for execution in Autumn of 2008, an assessment of performance improvement is to be carried out. That is where the need arose to have a
tool that would be capable of incorporating changes in the performance of individual railway processes (e.g. infrastructure availability, or rolling stock reliability, robustness of timetable), and to give an indication of this change on the overall performance. This became the so-called KPI Assessment Tool.

Decomposition of performance

Sharing information is not getting easier, especially in an international transport world, in a Europe where privatisation and liberalisation create a railway arena prone to competition rather than to integration. This is why it takes a lot to convince players that there are benefits for them in sharing their process information with others, so all can perform better. The InteGRail project has chosen a way to demonstrate this potential benefit of information sharing: a tree of Key Performance Indicators is made that provides an insight into each player’s contribution to their overall performance. At the top of the tree we find transport volume (passenger kilometres for passenger transport and gross ton kilometres for freight) and total cost of the railway processes. From there, performance is decomposed into lower level performance indicators for each of the railway sub-processes.

With overall transport volume at the top, together with overall cost, the following performance indicators become relevant:

- traffic manager and infrastructure manager work together to create a high number of paths that operators can use to run their service on
- operator and rolling stock manager in their turn work hard to run a high number of trains on these paths, in order to transport many passengers or a lot of freight.

This leads to the following contribution to transport volume:

- the infrastructure manager has to guarantee a high availability and reliability of his infrastructure, at an acceptable price,
- the traffic manager translates the available infrastructure into available paths for the operators, and has the right processes in place to actually carry out the timetable that the operators wish to run,
- the operator has to run all the paths he has claimed, at a high punctuality, all to guarantee customer satisfaction, so the customer keeps on coming back to use rail as the modality of his choice many more times,
- in order for the operator to do his work well, a rolling stock manager has to guarantee high availability and reliability of the fleet the operator uses to run his timetable, again at an acceptable cost.

While decomposing down higher level performances like punctuality and train cancellations into lower level performances like train and infrastructure availability and reliability, we find that there is a strong relation between the performances of each of the players. An infrastructure manager may use a lot of time to create a very reliable infrastructure, but the availability could be low because of all the planned maintenance time.

Therefore, the decomposition of the tree is not merely a split of responsibility between the various players, it is also a description of how interrelated most railway processes are.

Reasoning from the principle that an understanding of the interdependence of processes is needed before optimisation comes into sight, the InteGRail project focussed on technical dependence, leaving cost matters to be dealt with in a later stage.

Characteristics of the KPI tree

The InteGRail project consortium has jointly developed and adopted a KPI tree for railways. At the start of the project, a project-wide exercise was carried out to establish a KPI tree that was recognised by all. Starting from trees in four European countries or regions, a so-called generic KPI tree was developed. At the start of the project this generic tree was used to derive information sharing wishes, a process that was lead by CD (České dráhy). The same tree could later be used as the starting point for performance assessment in the project.
The KPI Tree is decomposed down to the performance indicator the project example functions intend to influence. For example, for the demonstrator about maintenance processes, the tree is able to distinguish between different reasons for infrastructure and rolling stock unavailability. This allows the assessment of the effect of unavailability on overall transport volume. Only then will the tool be able to illustrate the importance of collaboration between players and the sharing of information.

For this purpose now, the performance indicators listed in the tree was made “SMART”, meaning that all indicators in the tree can be made Specific to match with the scope of a certain situation or scenario, are expressed in a Measurable quantity, are Accepted by all stakeholders, are Realistic and available Timely for their purpose. This work was carried out in continuous discussions with the project’s Business Group, where all railway companies in InteGRail are represented. This Business Group is chaired by SNCF. The result was a list of over 40 “SMART” performance indicators used in railways.

For the purpose of assessment of the performance improvement in each of the three demonstration scenarios, the number of performance indicators could be brought down to about 20. These indicators constitute what became the “default tree” of the KPI Assessment Tool, and are shown in figure 1.
A tool to assess overall performance

The principle of the KPI tree was turned into a working software program, that can visualise and assess the performance dependences between the railway subsystems. As can be seen in figure 2, the tree is visualised as a “dashboard”, indicating the performance of each process. The tool can deal with a large number of performance indicators, in as many layers as are needed.

Figure 2:
Graphical representation
of the KPI Assessment Tool

In the tool, the following concepts exist:
- All performance indicators needed can be defined by the user, indicators exist as a node in the tree.
- Relations between nodes can be defined by the user by indicating which nodes are the “children” of a “parent” node.
- For visualisation purposes this already suffices to present the tree on the screen. Values can be changed either manually, or the node can be linked to an external database, accessible through the internet, and its value can be shown on the screen as well.
- The user can also program a formula to relate the parent to its children, using the standard operators +, -, /, x, ^ and brackets, or a look-up table. If formula are used, the tool recalculates all formulas once a lower level indicator is changed manually or through the internet connection. This way the tool ‘comes to live’, and becomes a true dashboard.
- A set of indicators (nodes) and their relations together define a tree. Once these indicators are given values (either manually or automatically through a formula or an external link) we say the tree is “populated”.
Each node in the tree can have a value that is real, simulated, manually chosen or calculated with the formula programmed, following the choice of the user of the tool. The function switch for each node is presented in figure 3.

In the KPI Assessment Tool, each value in the tree can either represent a measurement, can be set manually, can be the result of a simulation or the result of underlying performance indicators.

It is important to realise that the set of indicators, their relations and especially the values of the indicators will depend strongly on the scope or the scenario a specific tree was designed for. Or, in other words, for each situation, a specific set of indicators, relations and values will have to be defined. Once this is done conscientiously, the result can be used to model the railway reality in this specific situation.

To define a specific situation, the user can choose to either start a completely new tree or edit an existing tree. A default tree is included in the tool to serve as a logical starting point for relatively easy railway situations, and also for all three demonstration scenarios in the project. This default tree consists of almost 20 performance indicators, in 6 layers. The lowest level indicators are often parameters that can be measured directly in a railway process, like e.g. the number of rolling stock failures per year, the average time it takes to repair an infrastructure failure, or the average punctuality of a train service.

Using the KPI Assessment Tool

This KPI Assessment Tool will serve two purposes:

1 – Inside the InteGRail project scope
   In the project the KPI Assessment Tool will serve to assess the performance increase that can be achieved using the IGRIS modules that are developed in the project. The performance improvement these information system modules will bring, will be demonstrated in the project’s three Demonstration Scenarios. Each represents one or more principle railway business processes, where a realistic performance increase can be achieved and measured,

Figure 3:
In the KPI Assessment Tool, each value in the tree can either represent a measurement, can be set manually, can be the result of a simulation or the result of underlying performance indicators.

"Real-life": Measured in the "real world"
"Manual": Manual setting
"Simulation"
"Children": Combination of underlying KPIs
induced by the new information made available by the IGRIS modules. The demonstration manager will use the KPI Assessment Tool to model and visualise the performance increase he realises and to indicate the effect of this increase on the overall transport volume of this railway situation.

2 – Outside the InteGRail project scope
It will serve as a useful product to be used by railway players outside the scope of the InteGRail project. Players can use the tool on an individual basis, to model their own processes with respect to those of others. Or they can choose to form groups of players and study their interaction, in order to optimise their joint performance. The tool will allow the assessment of the performance of the overall systems, and will lead to better understanding of the interdependences between the railway subsystems. This will ultimately help Decision Making Units in the railway companies and processes to make better decisions, not just to improve the performance of their own processes, but also to improve the overall performance. It is envisaged to use the KPI Assessment Tool to organise management games. Using the tool will help railway decision makers see the interaction of all processes and will make them realise the importance of cooperation.

Conclusion
It should be noted that the tool will always present a rather simplified view of the railways. In each country the political situation is and will always be different, and the exact definition of each stakeholder’s role and the level of competition will vary from region to region. This is why any simple tool dealing with railway performance will have an added value at a fairly high abstraction level only.

Thinking about the high level performance in terms of transported volume helps in sorting out problems between the players. Ultimately, thinking in terms of high level performance might bring players to the conclusion that the contracts they have agreed between themselves are not optimal. Inappropriate contracts might introduce conflicts of interest where a mutual interest would be more appropriate.

Sharing views on the interdependence of all processes will also help to convince all players of the benefit they can all have when they start sharing process performance information.

It is expected that using the KPI Assessment Tool in the InteGRail project will show the benefit of assessing performance in this way. Once this will have proven to be a useful exercise it is expected that individual railway companies will start making similar assessments of their performance, hopefully together with their ‘partners in rail’.

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